groups of granites, in addition to the most important difference, to which I have drawn attention, with respect to their alkaline constituents; but I content myself at present with establishing this fundamental distinction between the two groups, and thus furnishing an additional proof of the service which may be rendered to geological science by the more exact and experimental sciences."

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Mr. Robert T. Forster, by permission of the Council, read a paper on the molecular formation of crystals: he first gave an account of preceding theories on this subject, and having shown in what respect these different theories failed, he proceeded to explain by what means we can account for the occurrence of secondary forms in general, and also advanced an hypothesis by which the formation of most hemihedral forms can be satisfactorily demonstrated, and the circumstances under which the various changes take place can be clearly pointed out.

"The first writer whom we find deserving of notice is Huygens, who considered the crystals of Iceland spar to be built up of spheroids. He did not, however, give any explanation why these spheroids are so aggregated.

"Hooke, in his 'Micrographia,' advanced a similar hypothesis, except that he considered the atoms to be spherical, a supposition which is utterly inapplicable to the third or rhombohedral system to which he applied it.

"The next writer who commanded attention was M. Prechtl; he considered a fluid to be made up of soft molecules, which, while the body was undergoing its change of state, suffered a change of form, arising from their mutual pressure, and that under different degrees of compressibility different forms were produced. Not only was this hypothesis quite insufficient, but it was also erroneous in a mathematical point of view, as Dr. Wollaston has fully shown.

"Immediately after him Dr. Wollaston published, in 'The

Philosophical Transactions,' a theory of the formation of the ordinary tetrahedron and octahedron, by means of spheres having a simple mutual attraction for each other; their arrangement may be best described as that of cannon balls piled into an equilateral triangular pyramid.

"I shall now endeavour to show that this theory is faulty, inasmuch as the molecules, if under the influence of mutual attraction, would never assume such an arrangement; for if any four molecules become attached they will form a triangular pyramid, and if a fifth become attached it will touch three others; but in his arrangement the fifth molecule touches only two others, and is in the same plane with three of them, a position which is certainly not that of equilibrium.

"Haüy considered the ultimate atom to have the same form as the solid obtained by cleavage, he did not explain under what law of attraction these particles become aggregated. His theory totally failed in accounting for the formation of crystals which have a tetrahedral cleavage, inasmuch as tetrahedrons will not fill space.

"Dana considers the molecules, in the first system, to be spherical and possessed of six poles or centres of force, situated at the extremities of three rectangular axes; in the other systems these sphere become spheroids or ellipsoids. By means of this hypothesis he satisfactorily explained the cubical and prismatic formations, and pointed out, like Haüy, how the secondary forms will result from certain decrements at the edges or angles.

"He also accounted for the occurrence of twin crystals by supposing that two molecules may unite at a point of equilibrium between two or three poles. He did not, however, show why decrements take place, nor is it possible on his hypothesis to explain how different cleavages can exist in the same system. His ideas are directly borrowed from Sir D. Brewster, who thus expresses himself:—'The phenomena of cleavage, and of hemitrope forms, would clearly indicate that the inte-

grant molecules are spheres, each having six poles on its surface, and it is owing to the different degrees of force possessed by these poles that the different cleavages are due.' In this he is clearly in error, for no matter with what cleavage we divide a cube, we will eventually separate every pole from every other.

"I will, in this paper, confine my observations to the first system, but it will be readily perceived that they apply (*mutatis mutandis*) word for word to the other systems.

"The cleavages are of three kinds, cubical, octahedral, and dodecahedral; the cubical we have already explained; the octahedral formation will arise if each spherical molecule have twelve poles on its surface, whose position is given by the intersections of four great circles, having the same inclination and relative position as the faces of the tetrahedron; the form which they will assume will be the same as Wollaston propounded.

"If each layer of molecules be deficient by one row, planes will appear on the edges, which planes belong to the cube; we have thus got a compound form consisting of the cube and tetrahedron, or in other words, we have a cube with half its corners replaced by planes. By other decrements at the edges, or corners, we can explain all forms of the first system, except hemihedral forms with parallel faces, which never combine with forms without parallel faces.

"Thirdly, the dodecahedral formation will result if each molecule be a sphere with eight poles on its surface, situated with respect to each other in the same positions as the angles of a cube; as can be very easily demonstrated.

"Any crystal will of course cleave in whatever direction the least resistance is met with. Thus in the cubical formation the cleavage is cubical because by such division we separate each molecule from one adjacent molecule only, whereas if we divided it in any other direction, we would have to separate each molecule from two or three others. In the octahedral

formation the cleavage is octahedral, for such cleavage overcomes the attraction of each molecule to three others, while any other would have to overcome the attraction of at least four. And in the dodecahedral the cleavage is in like manner parallel to the faces, as this cleavage destroys the cohesion of two poles, while the two other possible cleavages would destroy the cohesion of three and four respectively.

"With respect to the cause of decrements, they will evidently result from the loss of polarity in the external molecules, and this loss is what we would have every reason to anticipate; for if we consider the attraction of the particles to arise from the attraction of a fluid contained in them, and that this fluid is only held in its place by a certain coercive power of the molecule itself, as is the case with a magnet, it will follow, that as the crystal increases in size the combined attraction of the whole fluid will draw from the extreme molecules such fluid as they may contain, and thus they will lose their polarity.

"Thus, if the time which elapses while a layer of molecules is being laid on a cube, is equal to that which elapses while the polarities of the corner molecules is being removed, octahedral faces will appear; and in a similar manner we can explain all the other cases.

"In this theory we must of course suppose the particles of the fluid to be infinitely smaller than those of the crystal."